HIGH PERFORMANCE ELECTROCATALYST FOR PROTON EXCHANGE MEMBRANE FUEL CELL APPLICATION

IITM Technology Available for Licensing

Problem Statement

- The main electrocatalyst, platinum (Pt), used in proton exchange membrane fuel cells (PEMFCs) for oxygen reduction and hydrogen oxidation reactions is **expensive**, contributing significantly to the overall cost of the membrane electrode assembly (MEA).
- The **limited availability of platinum poses a barrier** to the widespread commercialization of PEMFCs.
- The current use of carbon-supported platinum (Pt/C) as a cathode electrocatalyst faces issues of electrochemical oxidation of carbon during fuel cell operations, leading to **Pt nanoparticle agglomeration** and detachment, resulting in degradation of fuel cell performance over time.
- The **slow kinetics of the oxygen reduction reaction (ORR)** at the cathode introduces a large over-potential, significantly reducing the performance of PEMFCs.

Intellectual Property

- IITM IDF Ref. **964**
- **IN 412563 - Patent Granted**

Technology Category/ Market

Advanced Fuel Cell Electrochemistry
Applications- Portable Electronics, Clean Energy Storage, Stationary Power Generation
Industry - Electronics and Energy Storage

Market - PEM Fuel Cell Market size valued at USD 2.8 billion in 2022 and is estimated to grow at over **8.4% CAGR** from 2023 to 2032.

TRL (Technology Readiness Level)

TRL - 4: Technology validated in lab scale.

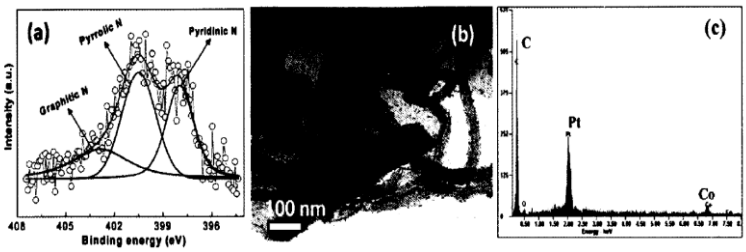

Figure 1: (a) XPS, (b) TEM and (c) EDX of Pt-3d TM/ nitrogen doped (graphene + MWNT) electrocatalyst.

Technology

- The present invention relates to **a method for manufacturing a high performance electrocatalyst for proton exchange membrane fuel ce**ll comprising steps of:

Synthesizing a composite of graphene and multi-walled carbon nanotubes (MWNT) by the strong electrostatic interaction between positively surface charged graphene and negatively surface charged MWNT enhancing the interaction between 1D MWNT and 2D graphene which prevents the restacking of graphene and gives highly conducting and large surface area nanostructure;

Coating nitrogen containing polymers over (graphene + MWNT) hybrid structure to obtain a highly uniform and well controlled coating; heating in pyrolysis chamber in inert gas atmosphere; and

Attaching Pt-3d TM alloy nanoparticles on the surface of nitrogen doped (graphene + MWNT) hybrid structure by modified polyol reduction technique.

Research Lab

Prof. Ramaprabhu, S.
Dept. of Physics

CONTACT US
Dr. Dara Ajay, Head
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
https://ipm.icsr.in/ipm/

Email: smipm-icsr@icsrpis.iitm.ac.in
sm-marketing@imail.iitm.ac.in
Phone: +91-44-2257 9756/ 9719

Key Features / Value Proposition

- Introduction of (Pt-3d TM) alloy nanoparticles onto nitrogen-doped (graphene + MWNT) enhances catalytic activity for PEMFCs.

Alloy Nanoparticles Integration

- Achieves a substantial maximum power density of 935 mWcm-2 at 60°C, outperforming commercial Pt/C (289 mWcm-2).

Impressive Power Density

- Demonstrates robust stability over 100 hours at 0.5 V in acidic medium, surpassing commercial Pt/C counterparts.

Prolonged Stability

- Alloying Pt with 3d transition metals enhances catalytic efficiency towards oxygen reduction reaction (ORR).

Improved ORR Performance

- Nitrogen doping of (graphene + MWNT) ensures strong binding for Pt-3d TM alloy nanoparticles, facilitating high metal dispersion.

Strong Metal Dispersion

- Excellent fuel cell performance and stability position the electrocatalyst as a viable choice for hydrogen-fueled vehicles and portable electronics.

Hydrogen-Fueled Applications

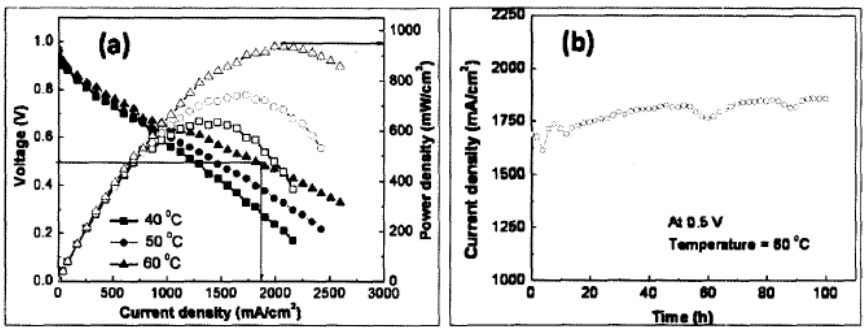

Figure 2: PEMFC (a) polarization curve and (b) stability studies of Pt-3d TM/ nitrogen doped (graphene + MWNT) electrocatalyst.

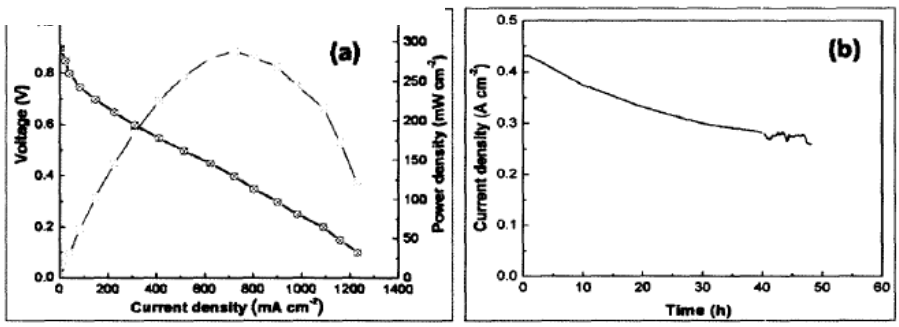

Figure 3: PEMFC (a) polarization curve and (b) stability studies commercial Pt/C electrocatalyst at 60 °C.

CONTACT US
Dr. Dara Ajay, Head
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
https://ipm.icsr.in/ipm/

Email: smipm-icsr@icsrpis.iitm.ac.in
sm-marketing@imail.iitm.ac.in
Phone: +91-44-2257 9756/ 9719